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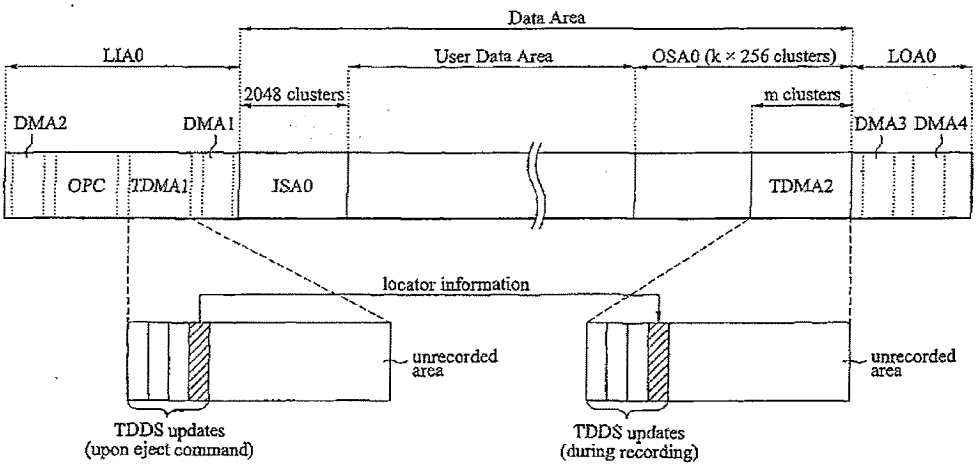
(54) **Title:** DEFECT MANAGEMENT METHOD FOR OPTICAL RECORDING MEDIUM AND OPTICAL RECORDING MEDIUM USING THE SAME



(57) **Abstract:** A method for defect management for an optical recording medium uses a plurality of temporary defect management areas (TDMAs), so that defect management information can be recorded in prescribed areas of an optical recording medium, such as a write-once Blu-ray disc, to include information specifying the location of a last defect management area among the temporary defect management areas, to represent the most recently recorded area and therefore contain the most current information. Defect management information is recorded (updated) in one of two temporary defect management areas, with disc-in-use defect management information being recorded in one TDMA and disc-eject defect management information being recorded in another TDMA, thus recording the last defect management information of an in-use disc when the disc is ejected.

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DEFECT MANAGEMENT METHOD FOR OPTICAL RECORDING MEDIUM AND OPTICAL RECORDING MEDIUM USING THE SAME

Technical Field

The present invention relates to optical recording media, and more particularly, to a defect management method for an optical recording medium and an optical recording medium using the same, in which a plurality of temporary defect management areas is used for defect management.

Background Art

Optical discs are widely used as recording media for storing large amounts of data for long periods of time. Such recording media can be largely divided into two types, including rewritable discs and write-once type discs. In data recording using a write-once type disc, only one write operation can be performed for any given area, while the rewritable disc affords much greater flexibility, particularly in terms of the management of defective areas. A defective area results from a manufacturing flaw in or subsequent damage to the surface of an optical recording medium that precludes recording data on one or more clusters.

If a defective area is found during the recording of data on an optical disc, the data written in the defective area is rewritten on an alternative area assigned by the manufacturer. At the same time, locator information, which is indicative of the defective area and its replacement recording area, is recorded for the defects of a given disc as defect management information in a defect management area (DMA). Thus, data to be recorded on an optical disc may be reproduced even if the disc exhibits defects on the recording surface.

This technique, however, is generally applied to rewritable discs, which allow free access to all data recording areas. Any necessary defect management

can therefore be accomplished with a relatively small DMA, which enables high-speed recording. Write-once type discs, on the other hand, require larger DMAs and more complex defect management due to their inherent write function limitations, and as a result, data recording operations typically require much more time.

Meanwhile, a new type of high-density optical recording medium, known as the HD-DVD, has been adopted for recording and storing high-quality audio and video data. An example of an HD-DVD recording medium is the Blu-ray disc, so named due to the use of blue rays (405nm), which are far denser than the red rays (650nm) used by conventional DVDs and can therefore store significantly larger amounts of data on standard-sized optical discs. Standardization of this technology is underway, to include standards for a write-once Blu-ray disc (BD-WO) and for a rewritable Blu-ray disc (BD-RE), particularly with regard to the detection and management of defective areas detected during data recording operations.

Importantly, any standardization of defect management for a write-once type disc (e.g., a BD-WO disc) should consider defect management using a rewritable disc (e.g., a BD-RE disc). Thus, the standardization of one should embrace as many common features of the other as possible, to maintain consistency and compatibility while striving for the efficient recording of defect management information to facilitate stable data reproduction operations.

In any event, the management of defective areas is crucial during data recording, particularly for high density DVDs such as the Blu ray disc, but current BD WO standards are inadequate. A unified standard, one that can accommodate the progressive demands of commercial systems for optical data storage, is required.

Disclosure of Invention

Accordingly, the present invention is directed to a defect management method for an optical recording medium, and an optical recording medium using the same, that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

An object of the present invention, which has been devised to solve the foregoing problem, lies in providing a method and apparatus by which defect management information is recorded on a plurality of temporary defect management areas of an optical recording medium, such as a write-once Blu-ray disc, to include information specifying the location of a last or latest defect management area among the temporary defect management areas, representing the most recently recorded area and therefore containing the most current information.

It is another object of the present invention to provide a defect management method for an optical recording medium, in which recording time is reduced.

It is another object of the present invention to provide a defect management method for an optical recording medium, which facilitates real-time recording.

It is another object of the present invention to provide a unified standard for write once optical recording media.

It is another object of the present invention to provide such a standard compatible with rewritable optical recording media.

It is another object of the present invention to provide a more efficient method for the management of defective areas during data recording on a write once optical recording medium.

It is another object of the present invention to provide a method for recording on an optical recording medium in which data security and data integrity is enhanced.

It is another object of the present invention to provide a method for recording management information on an optical recording medium, which enables adaptation to successive versions of the medium.

It is another object of the present invention to provide an optical recording medium for adopting the above methods.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent to those having ordinary skill in the art upon examination of the following or may be learned from a practice of the invention. The objectives and other advantages of the invention will be realized and attained by the subject matter particularly pointed out in the specification and claims hereof as well as in the appended drawings.

To achieve these objects and other advantages in accordance with the present invention, as embodied and broadly described herein, there is provided a method of defect management for a write-once optical recording medium having a plurality of temporary defect management areas, the method comprising a step of recording disc definition structure information in at least one of the plurality of temporary defect management areas, wherein the disc definition structure information includes continuously updated defect management information and locator information for accessing the continuously updated defect management information. The plurality of temporary defect management areas includes a first temporary defect management area for recording the continuously updated disc management information during a recording session and a second temporary defect management area for recording the continuously updated disc management information upon termination of the recording session.

In another aspect of the present invention, there is provided a write-once optical recording medium having a plurality of temporary defect management areas, wherein defect management information is continuously updated and

recorded in at least one of the temporary defect management areas. The continuously updated defect management information is recorded in each temporary defect management area.

The following detailed description is made particularly with respect to a write once Blu ray disc. Nevertheless, other write once type optical recording media may adopt the method and apparatus of the present invention. In addition, though most suited for optical discs using the BD WO format, the fundamental principles of the present invention may be adopted by optical discs using other formats, for enhanced data security and data integrity. Furthermore, while the embodiments of the present invention are described with respect to a single-layer optical recording medium, the same general disc structure and defect management method is applicable to a dual-layer optical recording medium, in which two primary TDMAs (one for each layer) and as many as three additional TDMAs are used.

It is to be understood that both the foregoing description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Brief Description of the Drawings

Further objects and advantages of the invention can be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagram for illustrating a defect management method for an optical recording medium according to the present invention;

FIGS. 2A-2C are diagrams of the TDMAs of FIG. 1, where FIGS. 2A and 2B illustrate the normal operation of the defect management method of the present invention and FIG. 2C illustrates a fail condition;

FIGS. 3A and 3B are diagrams of the TDMAs of FIG. 1, illustrating alternatives in recording the defect management information; and

FIG. 4 is a diagram of the TDMAs of FIG. 1, illustrating the recording of defect management information according to another embodiment of the present invention.

Best mode for Carrying Out the Invention

Reference will now be made in detail to the preferred embodiment of the present invention, examples of which are illustrated in the accompanying drawings. Throughout the drawings, like elements are indicated using the same or similar reference designations.

FIG. 1 shows a recording area of a write-once optical disc, such as a Blu-ray disc, to illustrate a defect management method for an optical recording medium according to the present invention, wherein defect management information is recorded in a temporary defect management area (TDMA). The optical disc is provided with a plurality of such TDMAs for each layer of an optical recording medium, with each TDMA occupying at least one cluster.

Each TDMA includes temporary disc definition structure (TDDS) information and a temporary defect list or TDFL, which are typically recorded in tandem, but for the purposes of the present invention, specific illustration and discussion of the TDFL has been omitted. In addition to a continuously updated counter, the TDDS information includes locator information (i.e., a physical sector number or PSN) corresponding to the latest (most recent) occurrence of defect management. Thus, the defect management information is recorded and reproduced based on the locator information of the latest defect management. In doing so, the locator information of the latest defect management is recorded in

the TDMA recorded as a new field in the form of the first PSN of the last TDDS, to occupy four bytes per field.

In a first preferred embodiment, the locator information may be represented by a single recording to indicate the last-recorded TDDS among all TDMAs. In a second preferred embodiment, the locator information may be represented by plural recordings to indicate the last-recorded TDDS for individual TDMAs. Here, assuming two TDMAs of TDMA1 and TDMA2, the TDDS information would include the first PSN of the last-recorded TDDS of the TDMA1 and the first PSN of the last-recorded TDDS of the TDMA2. In either case, one instance of locator information recording is performed for each instance of defect management and corresponds to the location of the current TDDS.

Meanwhile, the update counter of the TDDS is updated for each instance of TDDS recording, which is performed for each instance of defect management or at desired intervals to conserve recording space in a write-once optical disc. That is, the TDDS may be updated after a predetermined amount of recording, may be updated after the lapse of a predetermined of period since the last update, or may be updated based on a combination of factors, including a disc eject command.

In the preferred embodiment of FIG. 1, the recording area of an optical recording medium is divided into a lead-in area (LIA0), a data area, and a lead-out area (LOA0), the data area includes a user data area and has an inner spare area (ISA0) and an outer spare area (OSA0) assigned at either end. The TDMA2 is provided in the outer spare area, and TDDS updates that occur during recording are recorded in the TDMA2. At the time of a disc eject command, one TDDS update is recorded in the TDMA1, which is provided in the lead-in area.

Generally speaking, recording in the TDMA is accomplished by one of two ways: recording when the TDMA2 is available, i.e., when the TDMA2 is not fully recorded such that an unrecorded area thereof is available for recording, and

recording when the TDMA2 is unavailable, i.e., when the TDMA2 is fully recorded already such that no further recording area thereof is available, whereupon defect management is discontinued. If the TDMA2 is unavailable for recording, or if no TDMA2 is provided in the disc, there can be no defect management.

Assuming that the TDMA2 is available, there are in essence two stages of recording: during recording and after recording. During a recording session, the defect management information is recorded in the TDMA2 whenever the TDDS information is to be updated. Then, just before ejecting the disc, a final recording operation is performed, whereby the defect management information that was recorded in the TDMA2 during recording is recorded in the TDMA1.

In recording updated TDDS information in the TDMA1 according to the first preferred embodiment, the locator information of the last defect management in the TDMA2, which represents the current state of continuously updated defect management information, is recorded in the TDMA1 as part of the next TDDS. Included as part of the updated TDDS information recorded in the TDMA1 is the locator information of the last defect management, which points to the current defect management information recorded in the TDMA2. Here, the locator information of the last defect management is the recording location of the previous TDDS, which is identifiable by its update counter. That is, if the value of the update counter in the latest TDDS recorded in the TDMA1 is N, the value of the update counter for the locator information of the last defect management, i.e., the recording location of the last TDDS in the TDMA2, should be N−1. Here, it should be appreciated that the update counter of the TDDS is incremented each time the TDDS is recorded, or updated, in either the TDMA1 and TDMA2.

On the other hand, in cases where the TDMA2 is unavailable for recording, such that no further defect management information can be recorded, the TDMA1

is used to record the defect management information. In such cases, which may include discs having no assigned OSA from the manufacturer and therefore no TDMA2, defect management information can be recorded in a limited manner, for example, only when the disc is in use (during recording) or only when ejected (after recording).

Referring to FIG. 2A, it is assumed that the TDDS information is updated twice during one recording session, to be respectively recorded in the TDMA2 as TDDS1 and TDDS2. Upon generation of a disc eject command, i.e., upon completion of the recording session, the current TDDS information is stored in TDMA1 as TDDS3. Thus, TDDS3 includes the locator information of the latest defect management, and therefore contains the locator information of the last-recorded TDDS of the TDMA2, so that the TDMA1 may be read to locate the current TDDS information. Upon resumption of a next recording session, the TDDS is updated in the TDMA as TDDS4, as shown in FIG. 2B. After a conclusion of recording and at the time of disc ejection, regardless of the number of updates, the next TDDS update is recorded in the TDMA1 as, for example, TDDS5, which contains the locator information for the immediately preceding TDDS, e.g., TDDS4, which would be the most current TDDS.

Here, consecutive numbers refer to consecutive updates of the TDDS. Further recording sessions follow the above model, whereby TDDS updates that occur during recording are recorded in the TDMA2, with a final update being recorded in the TDMA1 just prior to ejecting the disc. Recording fail conditions can thus be recognized by reading the TDMA1, to check the value of the update counter of the last recorded TDDS, and comparing the read value with that of the last recorded TDDS in the TDMA2.

That is, referring to FIG. 2C where the recording of TDDS5 has not been achieved for some reason, for example, a power failure, the value of the update

counter of TDDS3, which is the last recorded TDDS of the TDMA1, is less than the value of the update counter of TDDS4, which is the last recorded TDDS of the TDMA2. It should be appreciated that, in normal conditions, the value of the update counter of the last recorded TDDS of the TDMA1 should always be greater than the value of the update counter of the last recorded TDDS of the TDMA2.

Upon recognition of a fail condition, continued recording may proceed normally by dealing with the failure in one of two ways. As one option, the next TDDS, i.e., TDDS5 or "disc eject" TDDS information, may first be recorded as usual in TDMA1, followed by further TDDS updates as necessary in the TDMA2. The information of the next TDDS is known by reading the TDMA to determine the highest update counter value. Since the continuously updated TDDS information always includes the locator information of the previous TDDS, information lost by a premature disc ejection can be restored. As an alternative, continued recording may proceed by simply advancing the recording process, thus skipping the recording of the disc eject TDDS information, to record as necessary the next TDDS in the TDMA2 and perform defect management processing based on the last recorded TDDS of the TMDA2.

FIGS. 3A and 3B illustrative alternatives in recording the disc eject TDDS information. As shown in FIG. 3A, the disc eject TDDS information is recorded in the TDMA1 only, but as shown in FIG. 3B, the disc eject TDDS information is recorded in both TDMAs. In any event, only the last defect management information is recorded when the disc is ejected.

In the second embodiment of the present invention to record updated TDDS information, the locator information indicates the recording location of the last defect management in each TDMA, by recording locator information in each. As shown in FIG. 4, the updated TDDS information includes locator information 1 and locator information 2, as access pointers recorded in the TDMA1 and TDMA2,

respectively. Thus, each recorded update of the TDDS information includes the locator information of the last defect management area of both TDMAs.

Industrial applicability

According to the present invention, defect management information is recorded (updated) in one of two temporary defect management areas, with disc-in-use defect management information being recorded in one TDMA, i.e., while the disc is in use, and disc-eject defect management information being recorded in another TDMA. Thus, the last defect management information of an in-use disc is recorded when the disc is ejected. As an alternative for cases where a second TDMA is unavailable, only the disc-in-use defect management information is recorded in a TDMA, and upon ejection, the latest defect management information is also recorded in a TDMA. In either case, a failure to record the last defect management can be recognized on the basis of the update-counter value when the use of the disc is resumed. Likewise, a successful recording of the latest defect management information can also be recognized and confirmed.

Also, the locator information of the last defect management in either TDMA can be used access the current TDDS information using one or two pointers, i.e., according to the first and second embodiments, respectively. On the other hand, the locator information of the last TDDS recorded in the TDMA1 is set to a value of "0h" when there is no spare area allocated for defect management and is set to a value of "Fh" when the TDMA2 is full such that continued defect management becomes impossible.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover

such modifications and variations provided they come within the scope of the appended claims and their equivalents.

What Is Claimed Is:

1. A method of defect management for a write-once optical recording medium having a plurality of temporary defect management areas, the method comprising a step of recording disc definition structure information in at least one of the plurality of temporary defect management areas, wherein the disc definition structure information includes continuously updated defect management information and locator information for accessing the continuously updated defect management information.

2. The method as claimed in claim 1, wherein the locator information corresponds to one of the plurality of temporary defect management areas.

3. The method as claimed in claim 1, wherein the locator information corresponds to each of the plurality of temporary defect management areas.

4. The method as claimed in claim 1, wherein the number of temporary defect management areas is two.

5. The method as claimed in claim 1, wherein the plurality of temporary defect management areas includes a first temporary defect management area for recording the continuously updated disc management information during a recording session and a second temporary defect management area for recording the continuously updated disc management information upon termination of the recording session.

6. The method as claimed in claim 5, wherein the locator information is recorded in a predetermined area of the recording medium.

7. The method as claimed in claim 6, wherein the predetermined area of the recording medium is one of the first and second temporary defect management areas.

8. The method as claimed in claim 5, wherein the disc definition structure information further includes a counter having a value that is updated for each recording of the disc definition structure information.

9. The method as claimed in claim 8, further comprising a step of performing defect management, wherein, if the highest counter value recorded in the second temporary defect management area is less than the highest counter value recorded in the first temporary defect management area, the defect management is performed immediately following the recording of the continuously updated defect management information of a recording session in the second temporary defect management area.

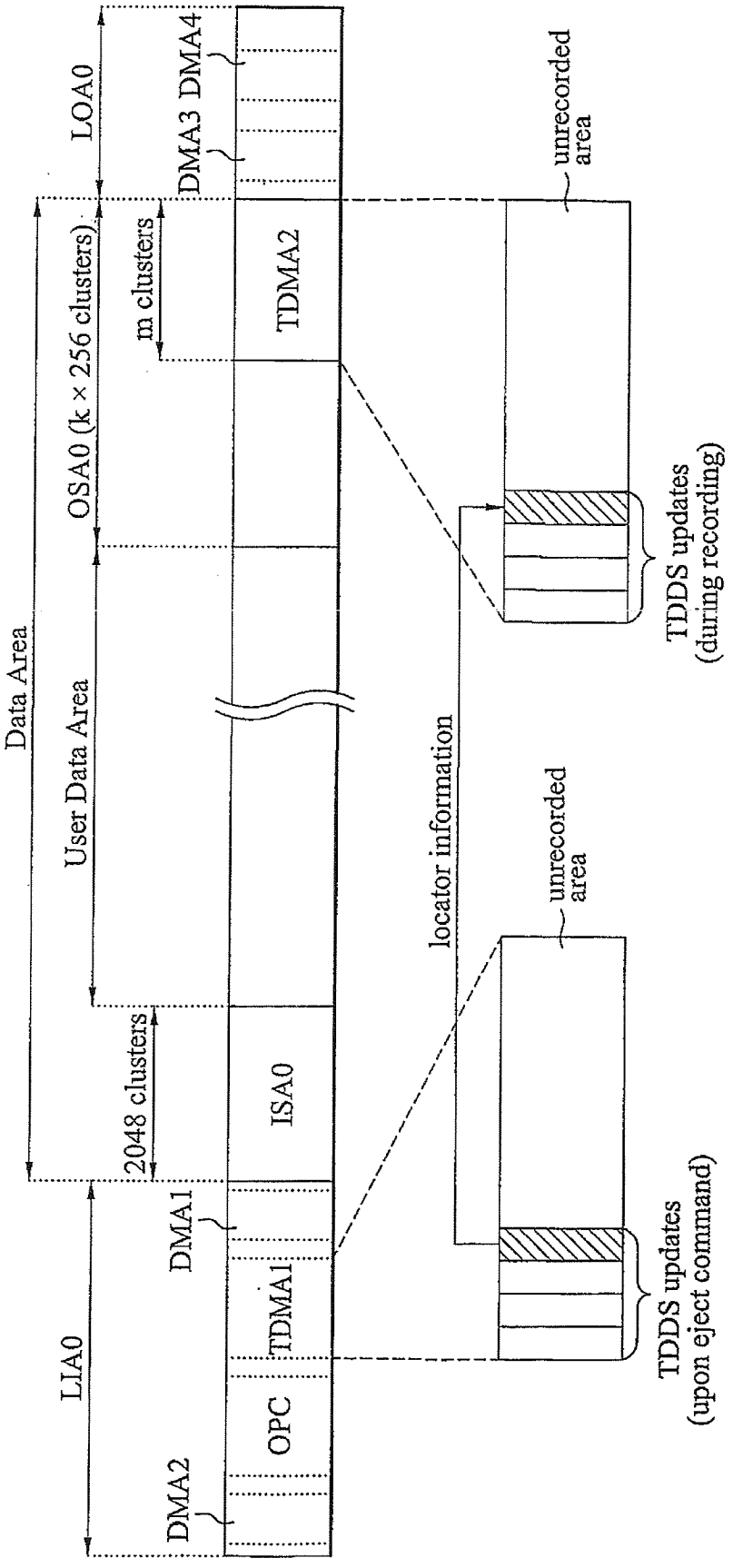
10. The method as claimed in claim 8, further comprising a step of performing defect management, wherein, if the highest counter value recorded in the second temporary defect management area is less than the highest counter value recorded in the first temporary defect management area, the defect management is performed immediately preceding the recording of the continuously updated defect management information of a recording session in the second temporary defect management area.

11. A write-once optical recording medium having a plurality of temporary defect management areas, wherein defect management information is continuously updated and recorded in at least one of the temporary defect management areas.

12. The write-once optical recording medium as claimed in claim 11, wherein the continuously updated defect management information is recorded in each temporary defect management area.

13. The write-once optical recording medium as claimed in claim 11, wherein the plurality of temporary defect management areas includes a first temporary defect management area for recording the continuously updated disc management information during a recording session and a second temporary defect management area for recording the continuously updated disc management information upon termination of the recording session.

FIG. 1



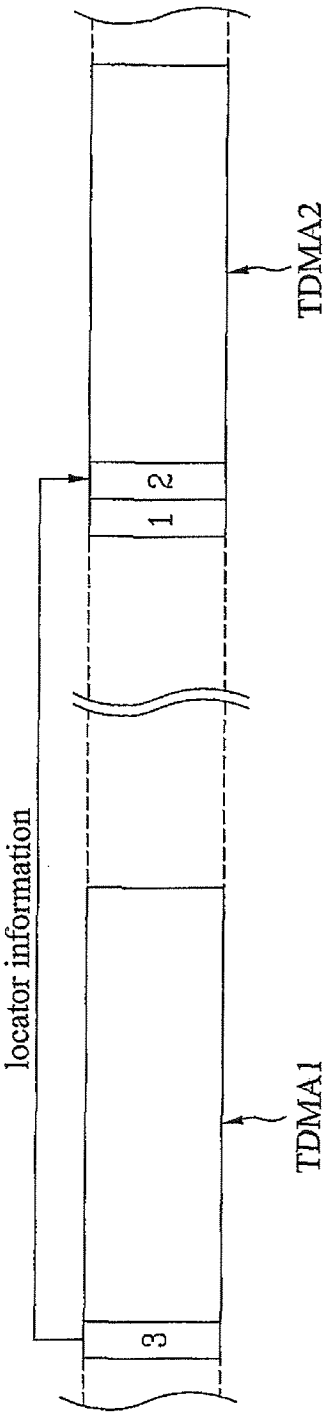

TDMA2
1
2
locator information
TDMA1
3

FIG. 2A

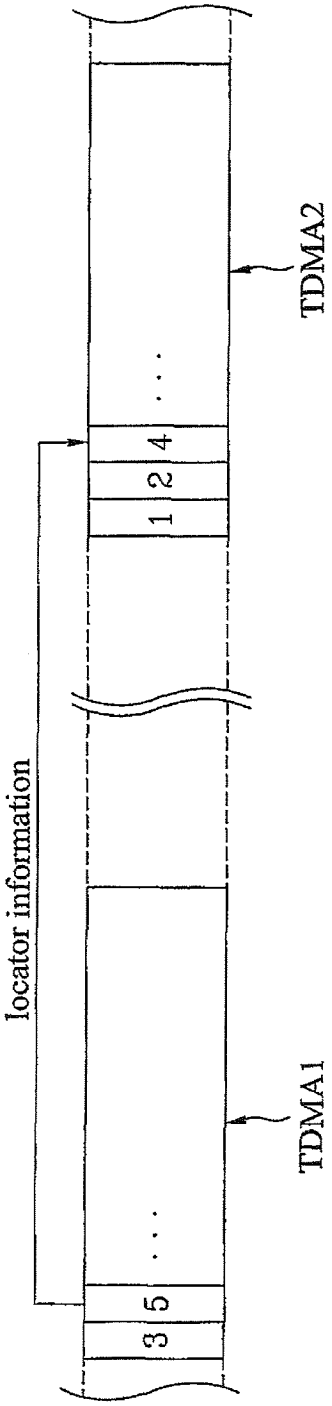

TDMA2
1
2
4
locator information
TDMA1
3
5

FIG. 2B

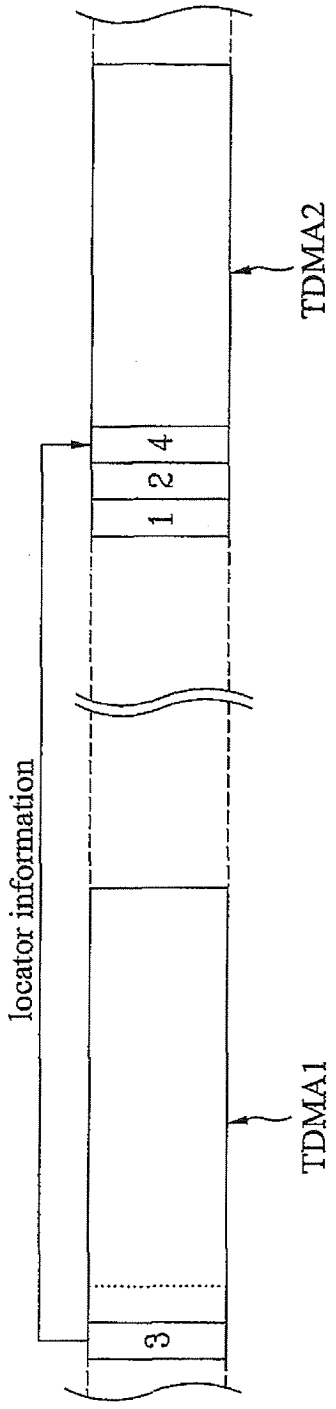


FIG. 2C

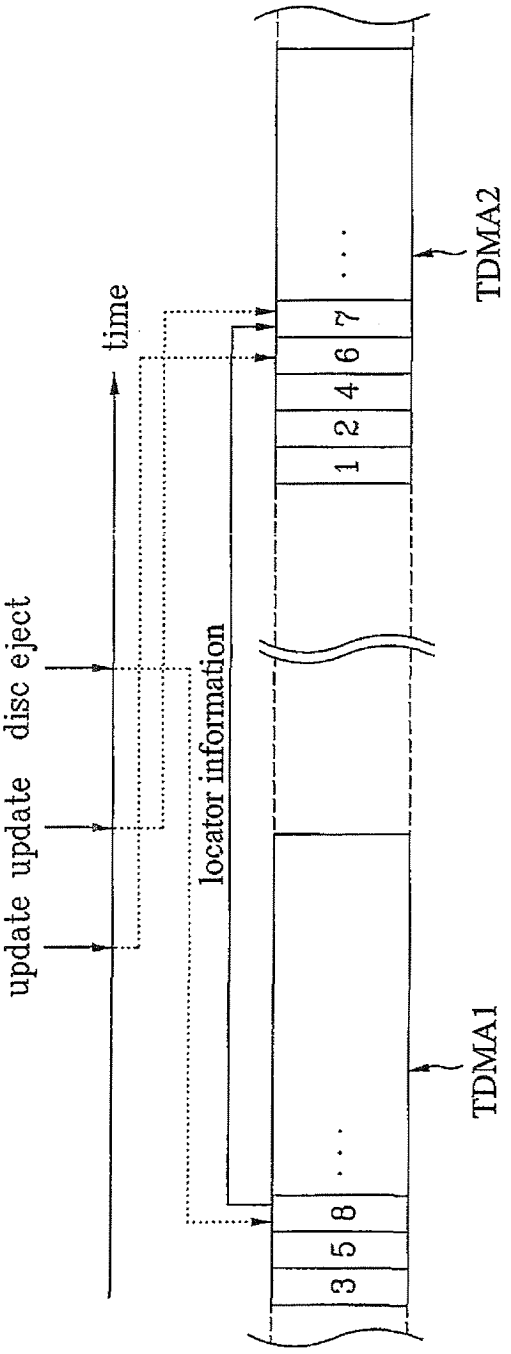

time
update update disc eject
locator information
TDMA2
TDMA1
1 2 4 6 7 . . .
3 5 8 . . .

FIG. 3A

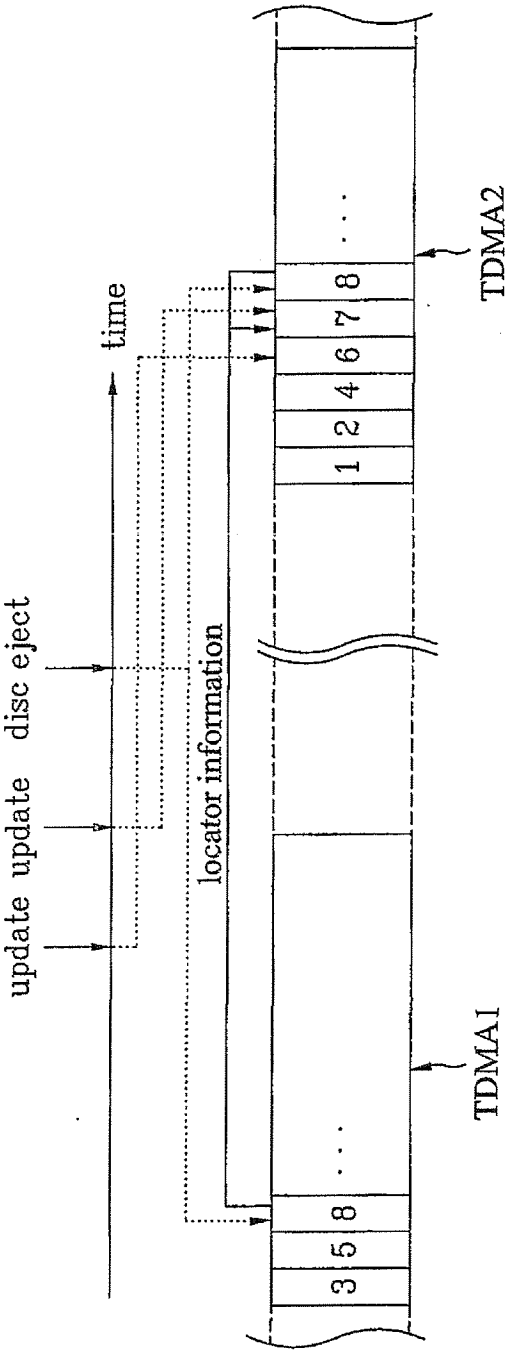

time
update update disc eject
locator information
TDMA2
TDMA1
1 2 4 6 7 8 . . .
3 5 8 . . .

FIG. 3B

FIG. 4

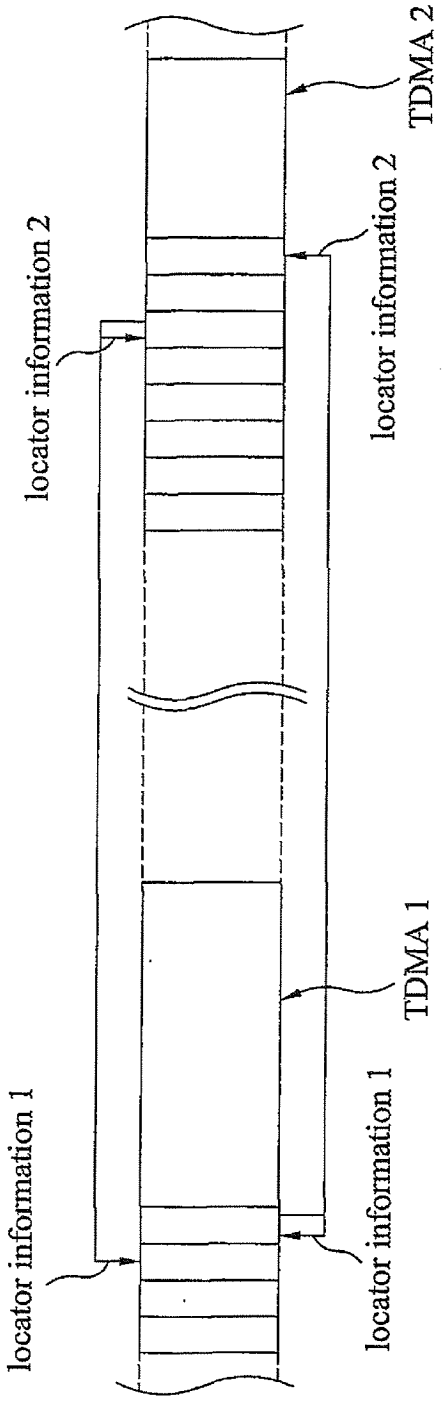
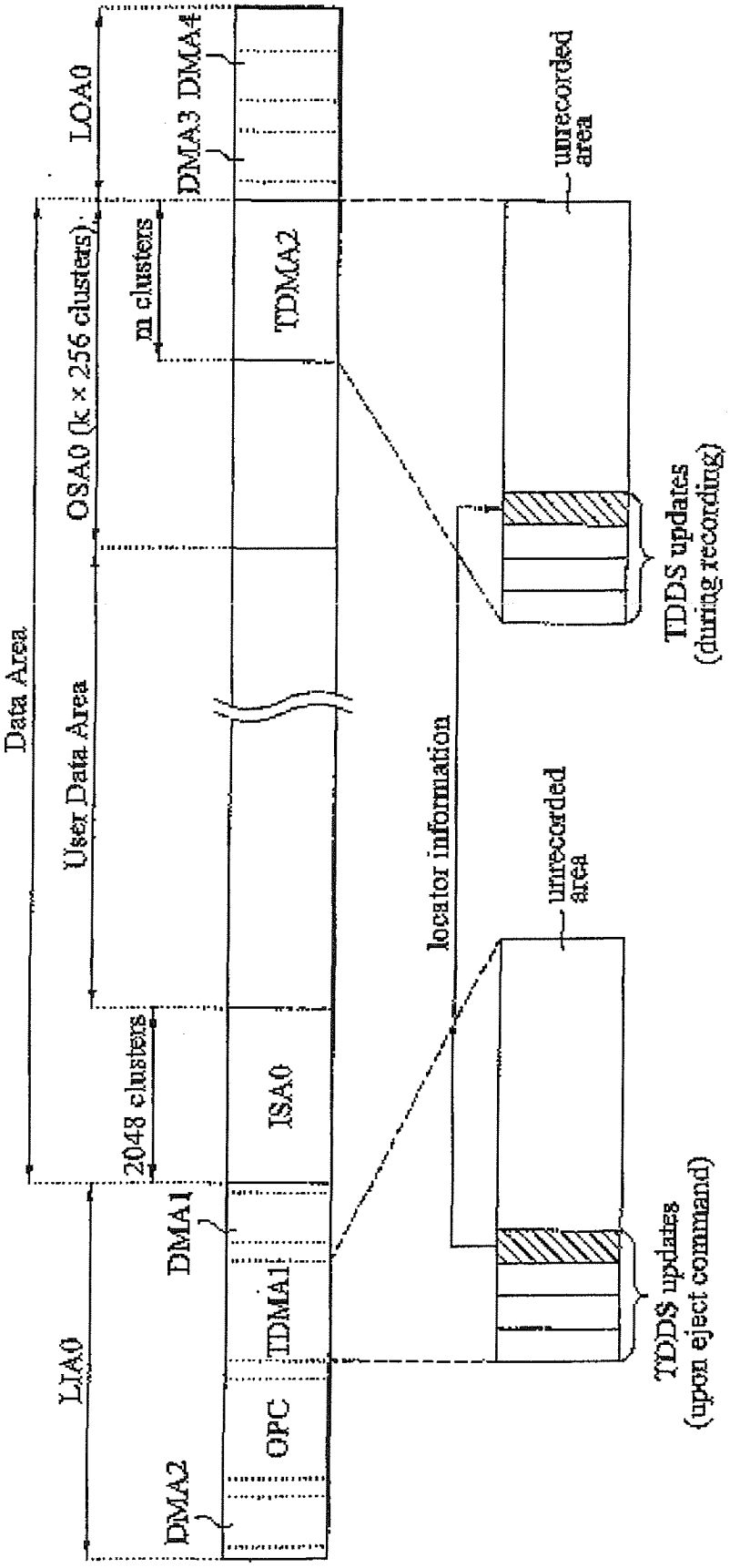


FIG. 1


Data Area
User Data Area
LOA0
OSA0 (k × 256 clusters)
DMA3
DMA4
m clusters
TDMA2
unrecorded area
TDDS updates (during recording)
locator information
2048 clusters
ISA0
DMA1
TDMA1
LJA0
OPC
DMA2
unrecorded area
TDDS updates (upon eject command)

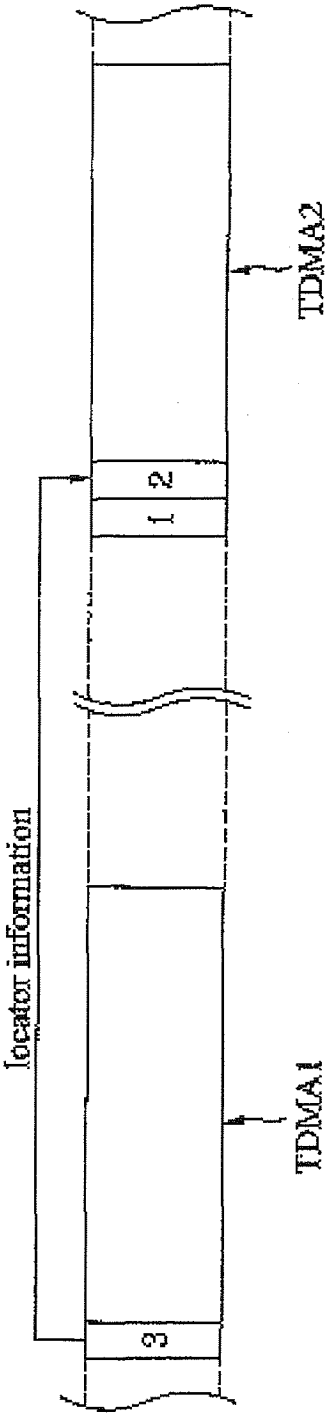

locator information
TDMA1
TDMA2
1
2
3

FIG. 2A

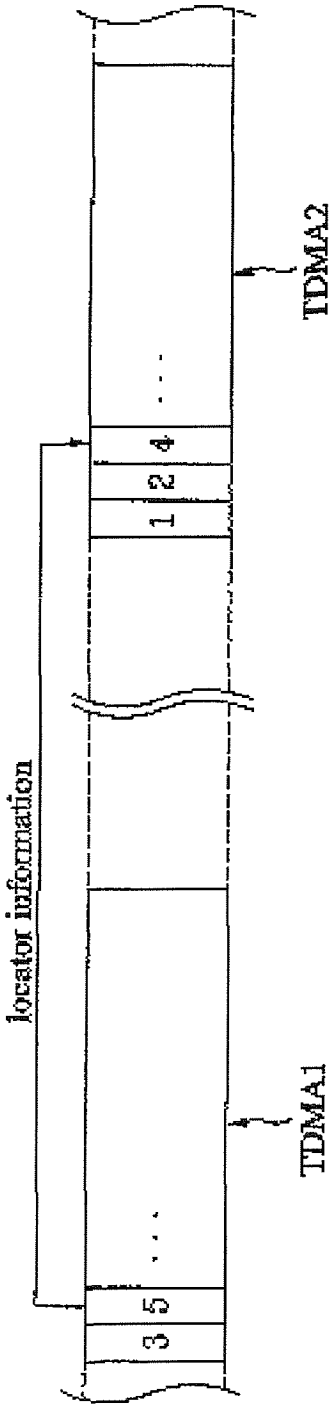

locator information
TDMA1
TDMA2
1
2
3
4
5

FIG. 2B

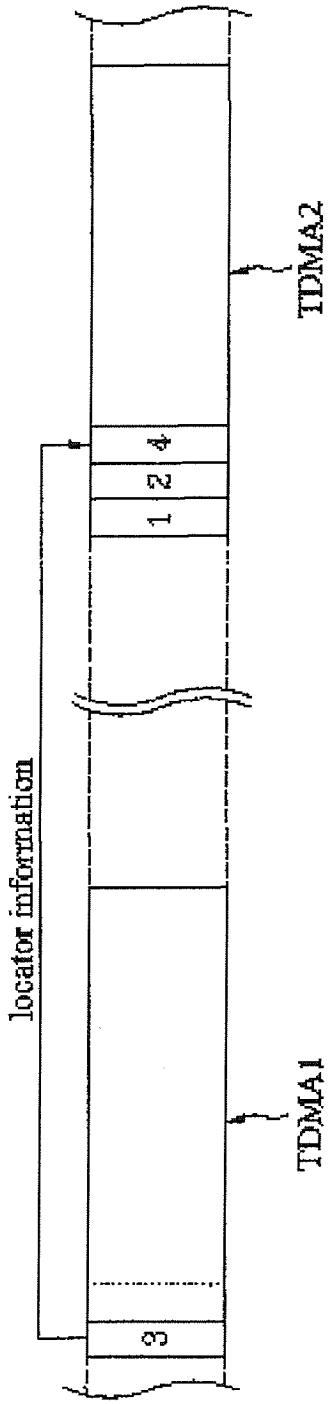


FIG. 2C

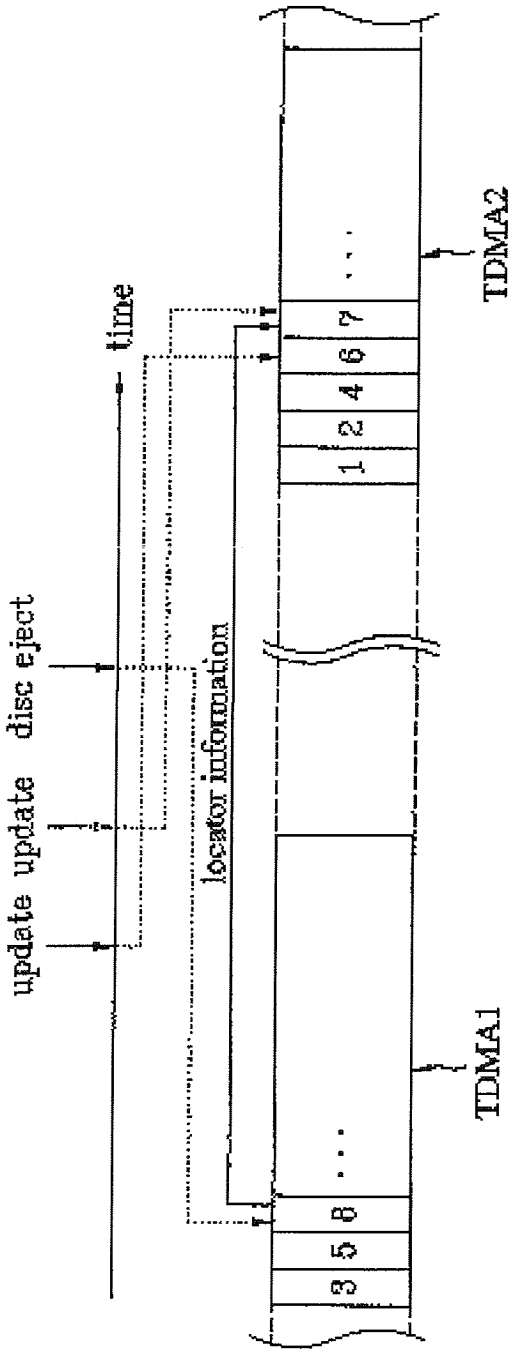


FIG. 3A

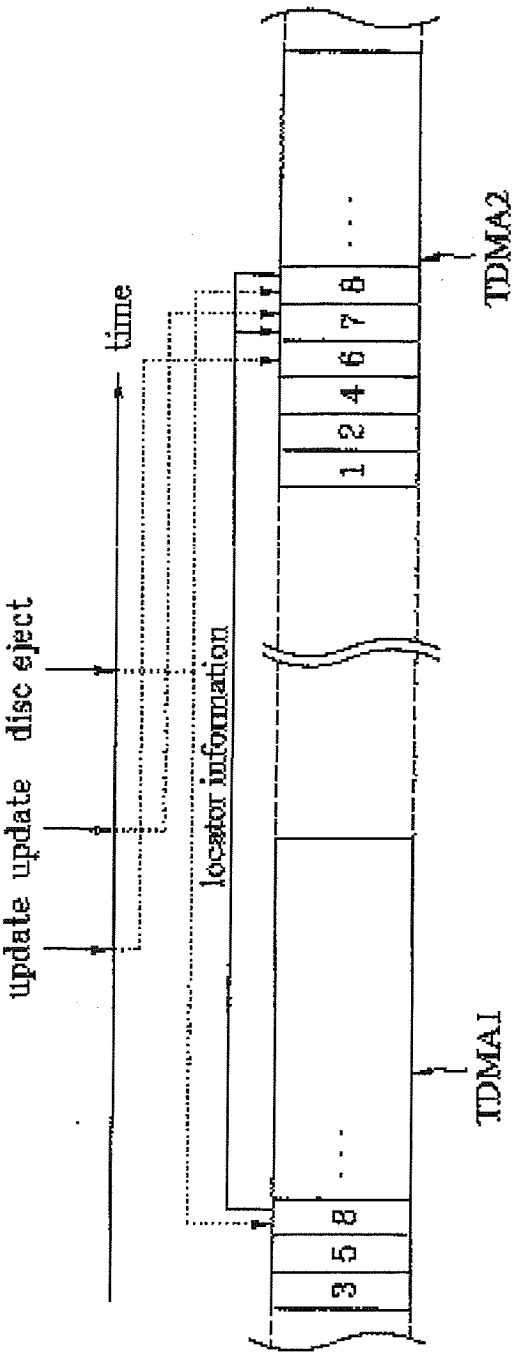
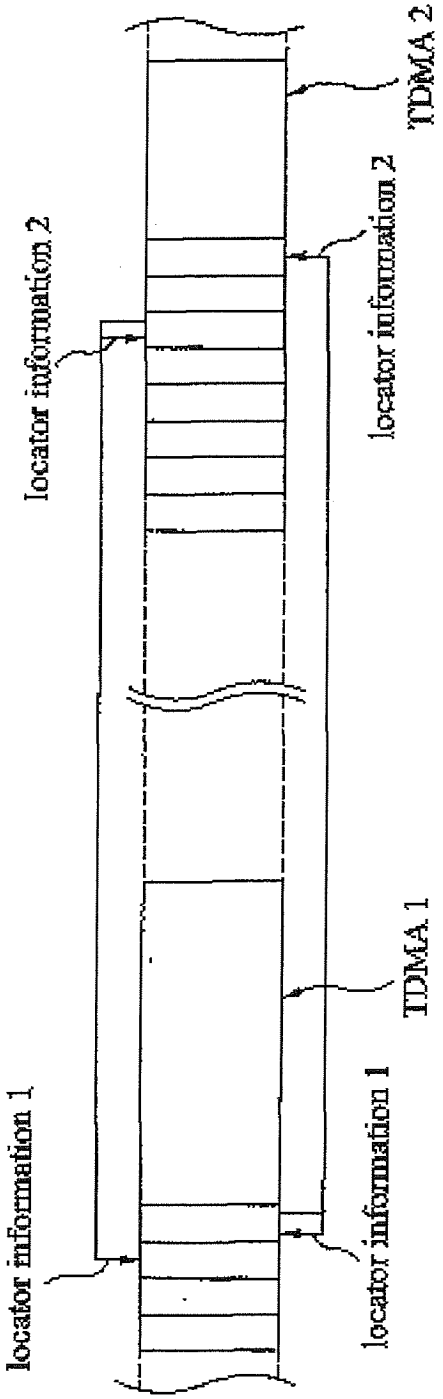


FIG. 3B

FIG. 4



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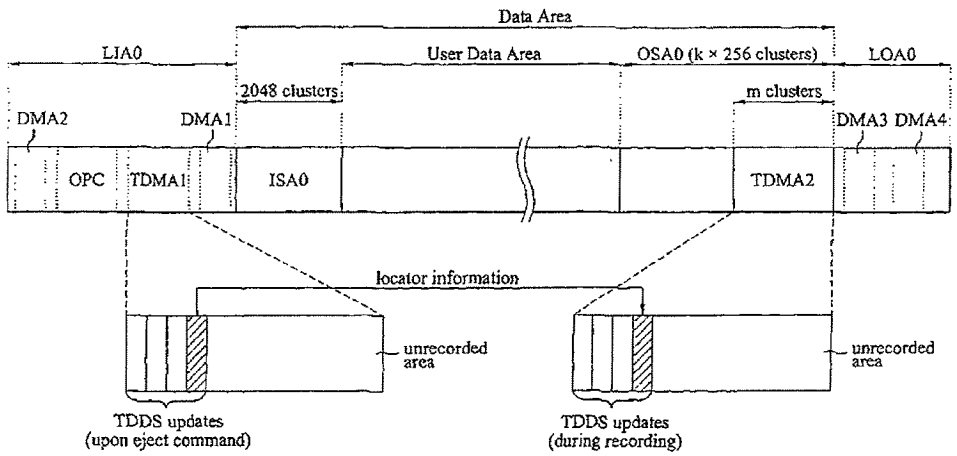
[Continued on next page]

(54) Title: DEFECT MANAGEMENT METHOD FOR OPTICAL RECORDING MEDIUM AND OPTICAL RECORDING MEDIUM USING THE SAME



(57) Abstract: A method for defect management for an optical recording medium uses a plurality of temporary defect management areas (TDMAs), so that defect management information can be recorded in prescribed areas of an optical recording medium, such as a write-once Blu-ray disc, to include information specifying the location of a last defect management area among the temporary defect management areas, to represent the most recently recorded area and therefore contain the most current information. Defect management information is recorded (updated) in one of two temporary defect management areas, with disc-in-use defect management information being recorded in one TDMA and disc-eject defect management information being recorded in another TDMA, thus recording the last defect management information of an in-use disc when the disc is ejected.

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A. CLASSIFICATION OF SUBJECT MATTER
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B. FIELDS SEARCHED

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G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
-

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 1152414 (MATSUSHITA) 7 November 2001 (07.11.2001)	1,11
A	GB 2356735 (MITSUBISHI) 2 January 2002 (02.01.2002)	1,11

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT
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		TW B 527583	2003-04-11
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